MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

Master of Electrical and Electronic Engineering

FINAL EXAMINATION, **SESSION 2015 / 2016**

EEE7256 – Device Processing and Fabrication

26 September 2015
2:30pm-5:30pm
(3 Hours)

INSTRUCTION TO STUDENT

1. This Question paper consists of 6 pages including cover page with 3 Questions only.
2. Answer all **THREE(3)** questions. The distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) i. According to the Federal Standard 209D, what does a cleanroom with classification of Class 100 mean?

[2 marks]

ii. An accidental spillage of an IPA bottle raised the cleanliness level of 10 m^2 cleanroom from Class 1000 to Class 100000. Assuming the air exchange rate of the cleanroom is 40 times per hour, estimate the time required for the air cleanliness to recover to Class 1000.

[4 marks]

(b) i. Describe the Laminar airflow system used in a modern cleanroom.

[2 marks]

ii. With the aid of a schematic diagram, describe the vertical laminar flow (VLF) station/hood and comment on how it keeps the wafer clean while performing wafer processing in the hood.

[6 marks]

iii. A 300 × 300 mm square substrate is exposed for 1 minute under laminar flow at 30 m/min. Estimate the number of dust particles that will land on this substrate in a Class 1000 clean room? Note: 1ft = 0.3048m.

[4 marks]

(c) With the aid of a simple schematic diagram, describe "Tunnel Bay" clean-room design strategy. What is the primary disadvantage of such cleanroom design?

[6 marks]

(d) Describe the following key cleanroom operating parameters require to ensure an effective operation of a modern cleanroom

i. Operating Temperature

[2 marks]

ii. Humidity

[2 marks]

iii. Operating Pressure

[2 marks]

Continued...

Question 2

(a) Name the four basic ingredients in photoresists and explain the function of each ingredient.

[4 marks]

Table Q2

Parameters	Positive Photoresist	Negative Photoresist
Oxygenation problem		
Adhesion		
Type of Developer solution		
Cost		
Swelling effect (During development)		

(b) i. Complete Table Q2 for direct performance comparison between a positive and negative photoresist.

[5 marks]

ii. You are requested to design a fabrication process and recipe for a microelectronic device which involves the selection of the right choice of photoresist where resolution is your main consideration. You have finally decided on positive photoresist. Justify your choice in terms of aspect ratio and pinhole counts.

[4 marks]

(c) i. With the aid of suitable diagrams, briefly describe the stepper aligner system that is widely used in the manufacturing environment for the fabrication of microelectronic devices.

[7 marks]

ii. State two advantages of the stepper aligner over the scanning projection aligner.

[2 marks]

iii. Briefly explain how alignment is achieved in the *stepper aligner*.

[2 marks]

(d) With the aid of suitable diagrams, explain in brief how a ***phase shift mask*** can be used to minimize the issue of image overlapping due to closely spaced mask pattern defined on the wafer.

[6 marks]

(e) Image resolution is also a function of spatial coherence (S) of the source. It has been determined that a resist is capable of resolving images with a modulation transfer function (MTF) of 0.4. Fig Q2 is the plot of MTF versus normalized spatial frequency of a grating. Based on Fig Q2, if the exposure tool has numerical aperture (NA) value of 0.35, an exposure source of wavelength 436 nm is used, and an S of 0.5, what is the minimum feature size that this tool can solve? What is the depth of focus?

[8 marks]

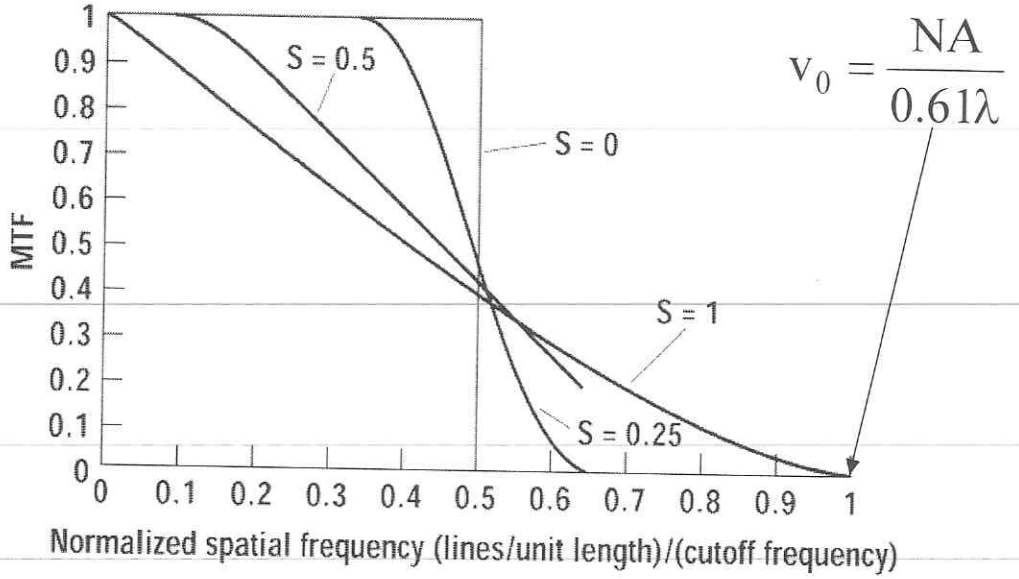

Figure Q2

Question 3

(a) Define the terms "wet etching".

[3 marks]

(b) The etch rate of using a wet etch can be classified as either

- Diffusion-limited process, or
- Reaction-rate limited process.

Explain the above two processes. Suggest and explain a method for each of the above processes to increase the etch rate.

[6 marks]

(c) A solution consisting of four parts of 70 % HNO_3, four parts of 49% HF, and two parts of CH_3COOH is used to etch silicon. Note that the etch rates in Fig. Q3 are expressed in terms of μm/min.

i. If the solution is held at room temperature, what etch rate would you expect?

ii. If the compound is to remain at two parts of CH_3COOH, what mixture of the same chemicals would be suitable to etch silicon at a rate of approximately 10μm/min.

[2 marks]

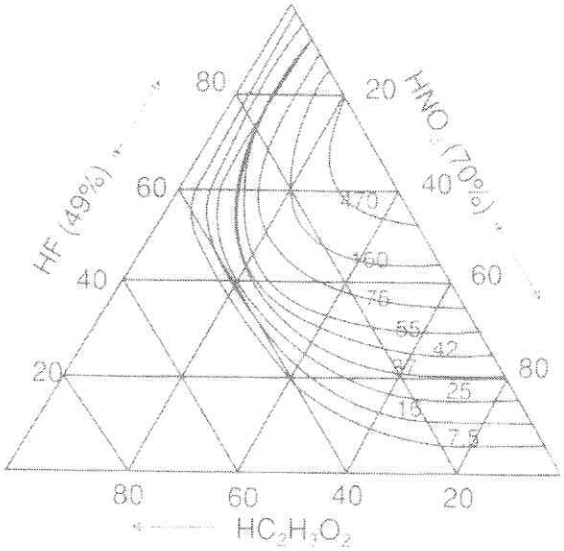

Figure Q3

(d) Dry etching is a method to remove semiconductor material to form the desire 3D structure on a wafer. With the aid of suitable diagrams,

i. Explain in brief the operation of an Ion milling dry etching system.

[5 marks]

ii. Describe possible problems/effects that may occur during ion milling process namely

- *Redeposition*
- *Trenching*

[4 marks]

(e) With the aid of diagrams, design a 12-step fabrication process flow to fabricate a ridge waveguide structure.

[12 marks]

End of Paper